



WASTE WISE: ENGAGING THE CITY IN WASTE RECYCLING

Aditya A Wadkar

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Arshan Shaikh

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Dr. Shrinivas A Sirdeshpande

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Laxmi Chandaragi

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Prof. Abhay Inchal

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Vidya V Gavade

Department of Computer Science and
Engineering
KLS VEDIT, Haliyal
INDIA

Abstract: The "Waste Wise: Engaging the City in Waste Recycling" project tackles the challenges of modern urban waste management by introducing an innovative online platform. In today's urbanized world, traditional waste disposal methods struggle with the increasing volumes of scrap materials and public waste. "Waste Wise" operates as a dynamic digital ecosystem, streamlining scrap collection through an intuitive mobile application. Citizens can effortlessly report and schedule scrap pickups, incentivized by a rewards system offering digital coins and discount coupons.

Simultaneously, scrap collectors benefit from real-time location details, optimizing their responsiveness. The platform extends its impact with a public waste reporting feature, allowing citizens to capture images of waste accumulations. These reports are seamlessly relayed to municipal authorities, facilitating swift and targeted public waste collection efforts.

The integration of GPS technology ensures accurate tracking of scrap collectors, enabling efficient navigation. "Waste Wise" envisions a paradigm shift in waste-management, leveraging technology for proactive citizen engagement, empowering scrap collectors, and enhancing collaboration with municipal authorities. The project aspires to create cleaner, more sustainable urban environments, marking significant strides towards intelligent and collaborative waste management.

This abstract encapsulates the essence of "Waste Wise"—a transformative solution that combines user-friendly technology, incentives, and collaborative reporting to address the complexities of urban waste management in a sustainable and efficient manner.

I. INTRODUCTION

"Waste Wise: Engaging the City in Plastic Recycling" project is a comprehensive solution designed to tackle the complex challenges associated with urban waste management. In today's urban settings, the conventional waste disposal systems often face inefficiencies, such as delayed scrap collection, inadequate citizen involvement, and improper public waste removal. This project introduces an innovative online platform to address these issues, creating a dynamic and interconnected system.

The concept of a smart city has become a crucial topic for enhancing urban living conditions. The Indian government has initiated the development of 100 smart cities. These cities incorporate advanced technologies, including sensor networks, cameras, wireless devices, high-speed networks like 5G, IT infrastructure, and data centers. These technologies collectively ensure efficient provision and management of essential services such as electricity, water supply, sanitation, recycling, and transportation. The "Waste Wise: Engaging the City in Plastic Recycling" project presents an innovative and comprehensive solution to the multifaceted challenges that plague contemporary urban waste management systems. In today's rapidly urbanizing world, conventional waste disposal methods often fall short in efficiently handling the burgeoning volumes of scrap materials and public waste.

This project introduces a transformative online platform, strategically designed to bridge the existing gaps in waste management by fostering collaboration among citizens, scrap collectors, and municipal authorities. At its core, "*Waste Wise: Engaging the City in Plastic Recycling*" operates as a dynamic digital ecosystem that streamlines scrap collection through a user-friendly mobile application, enabling citizens to effortlessly report and schedule their scrap pickups. To incentivize active participation, the project introduces a rewards system, offering digital coins and discount coupons to citizens who contribute to waste recycling efforts. Simultaneously, scrap collectors are empowered with essential information, including real-time location details, to optimize their efficiency in responding to citizen requests. Notably, the platform extends its impact beyond individual scrap collection, incorporating a public waste reporting feature where citizens can capture images of waste accumulations in public spaces.

These reports are seamlessly relayed to municipal authorities, complete with precise location data, facilitating swift and targeted public waste collection efforts. The integration of GPS technology ensures real-time tracking of scrap collectors, enabling accurate navigation to specified locations.

In essence, "*Waste Wise: Engaging the City in Plastic Recycling*" envisions a paradigm shift in waste management, leveraging technology to instigate proactive citizen engagement, empower scrap collectors, and enhance collaboration with municipal authorities. Through this holistic approach, the project aspires to create cleaner, more sustainable urban environments, making significant strides towards a future where waste is managed efficiently and collaboratively.

This information can be used to identify areas where waste reduction can be achieved, such as through recycling and composting programs. For example, sensors can be placed in waste bins to detect when they are full and need to be emptied, or cameras can be used to monitor the contents of waste bins to ensure that the correct materials are being disposed of in the correct bins. The data collected by these sensors can then be used to optimize waste collection schedules and routes. For example, if a certain bin is consistently full at a certain time of day, the waste collection team can be alerted to empty it before it overflows. This can help to reduce the amount of time and resources that are spent on waste collection. Overall, introducing a *Waste Wise: Engaging the City in Plastic Recycling* in a Society can have numerous benefits, including reduced waste volumes and associated costs, improved environmental sustainability, and increased awareness and education around waste reduction. By implementing such a system, can set an example for sustainable waste management practices, and help to reduce their environmental impact.

II. LITERATURE SURVEY

Recycling waste holds significant value as it can serve as a raw material. Our observations and data collection from Bangsaen Beach in Saensuk City, Chon Buri Province, Thailand, revealed that much valuable waste is discarded improperly rather than being sorted and collected. This not only creates issues with raw material shortages but also contributes to environmental pollution. We identified two primary reasons for improper waste disposal: 1) a lack of basic knowledge on correctly separating valuable waste, and 2) insufficient motivation to do so. To address these issues, we developed a comprehensive waste management system utilizing modern Information Technology. The system comprises two parts: software and hardware. The software includes a web-based waste management application and a mobile app-based rewarding system. The hardware, utilizing Internet of Things (IoT) and Machine Learning technologies, automatically recognizes and separates three types of waste: glass bottles, plastic bottles, and metal cans. Testing showed that the system performed as expected, effectively sorting the three types of waste. The mobile app rewards users with points for proper waste disposal, encouraging them to participate.[1]

Plastic is extensively used globally due to its adaptability, making it a prevalent material in various industries. However, the current levels of plastic consumption and disposal present significant environmental challenges. Recycling plastic is crucial to address this issue, though it remains one of the most demanding sectors within the plastics industry. A substantial portion of recycled plastic is used to create disposable packaging or other short-lived products, leading to sustainability concerns. The durability of plastic polymers results in large amounts of waste accumulating in landfills and natural environments. Energy-efficient plastic recycling requires sophisticated machinery and innovative manufacturing processes. This paper proposes an environmentally friendly solution for recycling plastic bottles, involving three stages: 1) establishing a collection system for water and soda bottles, 2) designing a production line to process plastic bottles into various sizes of plastic ribbon/wire, and 3) using the plastic ribbon/wire to create products such as tables, chairs, roofing materials, and decorations. Economically, this project aims to reduce waste processing costs and create employment opportunities, particularly in rural areas, while producing affordable plastic products for low-income families. Socially, it seeks to enhance environmental conditions, reduce landfill waste, prevent disease spread from plastic waste, eliminate contamination from burning plastic, and raise public awareness

about environmental protection. A prototype developed at Duy Tan University in Vietnam demonstrates the process of cutting bottles into ribbon/wire and continuously connecting them. The pilot test results of using plastic ribbon/wire to manufacture new products will be presented, along with a sustainable economic model of entrepreneurship partnership for developing economies.[2]

Mobile applications are increasingly used to enhance urban waste collection systems. These applications help inform residents about collection schedules, source-separation guidelines, and associated fees. An example is the "I Got Garbage" app in India, which allows households to request waste collection services. [3]

Technological advancements are transforming waste management globally. Governments and waste management companies are leveraging technology across the value chain to cut costs, boost material recovery for energy, and engage with the public. However, the choice of technology varies by context, as communities differ in geography, technical capabilities, waste types, and income levels. Sometimes, the most effective solution is not the latest or most advanced technology. For instance, while a mobile app might effectively inform residents of service changes in a wealthy city, radio advertisements could be more suitable in areas with high illiteracy rates. This section explores various technologies, from simple to advanced, that are enhancing waste management worldwide.[3]

Maintaining a clean civic environment is essential yet challenging, particularly in developing countries. To involve citizens in monitoring their neighborhoods, this paper introduces SpotGarbage, a novel smartphone app designed to detect and segment garbage areas in user-clicked, geo-tagged images. The app employs a deep architecture of fully convolutional networks to identify garbage in images, trained on the newly introduced Garbage In Images (GINI) dataset with a mean accuracy of 87.69%. Additionally, the paper suggests network architecture optimizations that reduce memory usage by 87.9% and prediction time by 96.8%, without compromising accuracy, making the app suitable for use on resource-limited smartphones.[4]

Material recognition in real-world images poses significant challenges due to diverse surface textures, geometries, lighting conditions, and clutter. This paper introduces the Materials in Context Database (MINC), a large-scale, open dataset designed for deep learning applications in material recognition and segmentation in natural images. MINC is significantly larger and more diverse than previous material databases, covering 23 categories comprehensively. Using MINC, convolutional neural networks (CNNs) were trained for material classification from image patches and for simultaneous recognition and segmentation in full images. For patch-based classification, the best CNN architectures achieved a mean class accuracy of 85.2%. These trained CNN classifiers were then adapted into a fully convolutional framework combined with a fully connected conditional random field (CRF) to predict materials at every pixel, achieving a mean class accuracy of 73.1%. The experiments underscore the importance of a large, well-sampled dataset like MINC for effective real-world material recognition and segmentation. [5]

III. PROBLEM STATEMENT

Managing waste efficiently in urban areas has become increasingly challenging due to the rising amounts of waste and the complexities involved in coordinating its collection and disposal. Traditional waste management practices, which largely depend on manual operations, often result in inefficiencies, delays, and poor allocation of resources. Additionally, the lack of transparent communication and coordination among residents, municipal workers, and scrap collectors further complicates the timely resolution of waste-related issues.

To mitigate these challenges, a comprehensive web application is essential to streamline waste management processes. This application would act as a centralized platform, enabling users to report garbage complaints and request scrap collection services. It should promote effective communication and collaboration among all stakeholders, facilitating efficient tracking, prioritization, and resolution of waste management problems. Incorporating geospatial features like GPS mapping is crucial for accurate location tracking and navigation for municipal workers and scrap collectors.

Thus, the proposed web application is designed to be a user-friendly and scalable solution that empowers residents to effectively report waste-related issues, ensures transparent communication and coordination among stakeholders, and optimizes resource allocation and response times for waste collection and disposal. By addressing these key issues, the solution aims to foster cleaner, healthier, and more sustainable urban communities.

IV. SURVEY OF OUR WORK

The “Waste Wise: Engaging the City in Plastic Recycling” project began by collecting data from users on how plastic waste is managed in daily life. Data collection and surveys are crucial steps in implementing such systems. For this real-time project, we visited several cities, including Dharwad, Hubli, and Haliyal. We interacted with residents, asking them about their methods for managing and disposing of plastic waste at home or in their shops. The responses were generally positive, with many noting that municipal plastic waste collection occurs weekly. However, some areas faced issues due to a communication gap between users and municipal workers, leading to inconsistent collection schedules and inefficiencies.

Our project focuses on both household and public place plastic waste management. By explaining our initiative to the community, we found a strong consensus on the need for a systematic approach to plastic waste management. Many individuals were unaware of proper recycling methods. Therefore, our project not only implements a software solution for plastic waste collection and management but also educates the public on recycling processes.

Engaging with the community allowed us to understand their perspectives and attitudes towards waste management and recycling. Our goal is to enhance public knowledge by providing resources and a digital platform.



Figure.1 Project Survey ,Interaction With Citizens.



Figure.2 GSM Plastic Industry

In addition to community interaction, we visited GSM Plastic Industries to gather detailed information on their recycling processes. Located at Plot No. P2, 5th Main Rd., KSSIDC Industrial Estate, Belur Industrial Area, Karnataka, the purpose of this visit was to understand their recycling operations, sustainability practices, and gather relevant data for our project.

The recycling process at GSM Plastic Industries includes several stages:

- Collection: Acquiring plastic waste from specific sources or collaborations.
- Sorting: Separating different types of plastics.
- Cleaning: Removing contaminants from the plastic.
- Shredding/Granulation: Breaking down plastic into smaller pieces.
- Extrusion/Molding: Processing recycled plastic into new products.
- Quality Control: Ensuring the final products meet industry standards.

GSM Plastic Industries processes post-consumer and post-industrial PET bottles into PET bales and washed PET flakes. These materials are used to produce various products like polyester staple fiber (PSF), polyester yarn (POY), extruded PET sheets, PET straps for box packing, PET preforms, and recycled PET resin. Their products cater to both domestic and international markets, including China, Taiwan, Korea, the USA, and various European and Asian countries.

V. SOLUTION APPROACH

- Centralized Platform for Waste Management:

The web application provides a centralized platform where users can register complaints about garbage accumulation and request scrap collection services. This centralization streamlines the process of waste management by consolidating all complaints and requests in one place, making it easier for relevant stakeholders to track and address issues efficiently.

- Seamless Communication and Collaboration:

The application facilitates seamless communication and collaboration between users, municipality personnel, and scrap collectors through real-time messaging and notification features. Users receive updates on the status of their complaints and requests, while municipality personnel and scrap collectors can communicate with users and each other to coordinate response efforts effectively.

- **Efficient Tracking and Prioritization:**

Utilizing Firebase Firestore as the backend database, the application enables efficient tracking and prioritization of garbage complaints and scrap collection requests. Data is stored in a structured format, allowing municipality personnel to categorize and prioritize requests based on factors such as severity, location, and urgency, ensuring that resources are allocated effectively.

- **Integration of Geospatial Functionality:**

The integration of the Google Maps API provides geospatial functionality, allowing users to pinpoint the location of garbage accumulation and scrap collection requests accurately. Municipality personnel and scrap collectors can view requests on a map interface, enabling them to navigate to the site of complaints and requests efficiently, thereby reducing response times and improving overall operational efficiency.

- **Secure and Scalable Architecture:**

The application is built on Firebase, a secure and scalable platform that provides robust authentication, real-time database capabilities, and server-less functions. Firebase Authentication ensures secure access to application resources, while Firebase Fire-store offers scalability and flexibility for storing and managing data. Firebase Cloud Functions enable the execution of back-end logic, enhancing the application's functionality and responsiveness.

VI. SYSTEM ARCHITECTURE AND DESIGN

Client-Side:

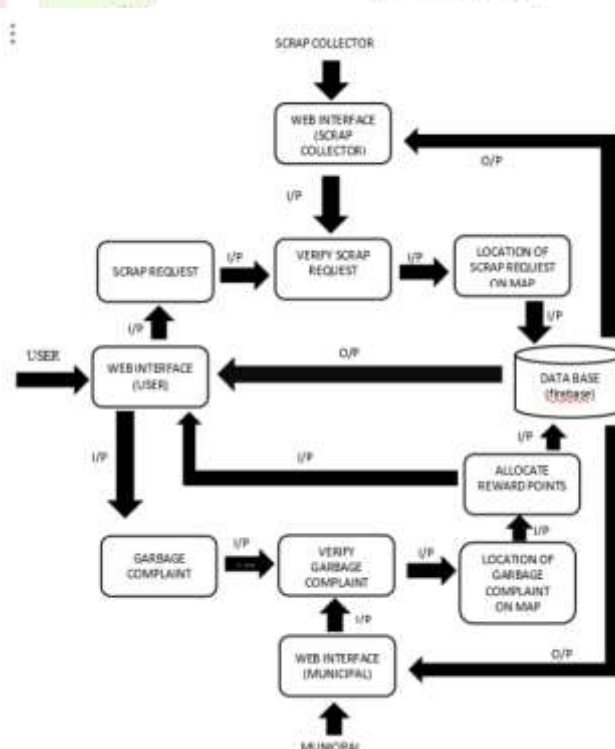
- Next.js: Handles the frontend logic and rendering of pages.
- Tailwind CSS: Provides styling and layout utilities.
- JavaScript/React: Handles dynamic client-side interactions.

Server-Side:

- Firebase: Acts as the backend service to store data and handle authentication.
- Firebase Authentication: Manages user authentication and authorization.
- Firebase Firestore: Stores data related to user complaints, scrap requests, and other relevant information.
- Firebase Cloud Functions: Used for serverless functions, such as sending notifications or handling complex backend logic.

External Services:

- Google Maps API: Integrated for GPS functionality to display maps and provide navigation features.



VII. SYSTEM COMPONENTS

User Panel:

- Garbage Complaint Option: Allows users to register complaints about garbage accumulation.
- Scrap Request Option: Enables users to request scrap collection services.

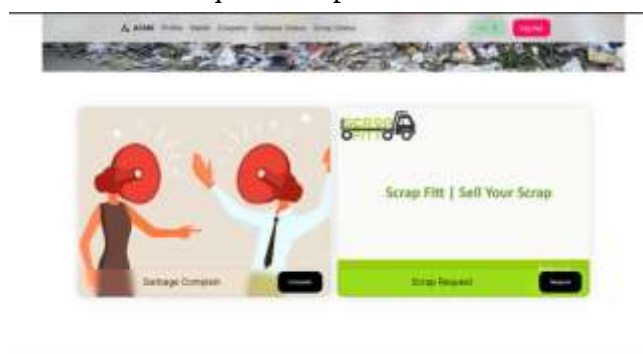


Figure.3 user can complain grabage and raise the scrap request.

Municipality Panel:

- View Requests: Displays a list of garbage collection and scrap requests.
- Resolve Requests: Allows municipality personnel to mark requests as resolved after addressing them.



Figure.4 List of Unsolved garbage collection request.



Figure. 5 List of Solved garbage collection request.

Scrap Collector Panel:

- View Requests: Shows a list of pending scrap collection requests.
- Accept Requests: Enables scrap collectors to accept and mark requests as completed..



Figure.6 .Displays the total number of request and number of unsolved request and total number of solved request.

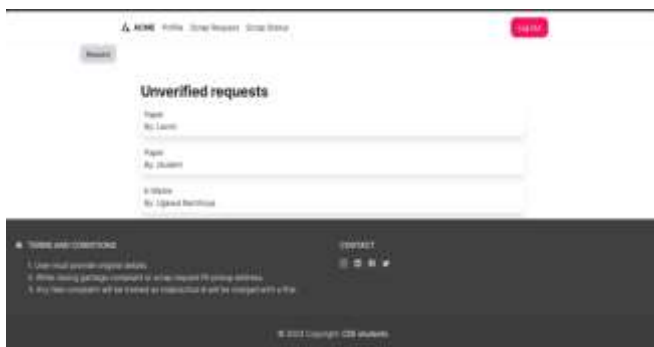


Figure.7 List of Pending scrap collection request .



Figure.8 List of solved scrap collection request.

VIII. DESIGN CONSIDERATIONS

User Interface (UI):

- **Responsive Design:** Ensure the application works seamlessly across different devices and screen sizes.
- **Intuitive Navigation:** Design an easy-to-use interface for users, municipality personnel, and scrap collectors.
- **Clear Call-to-Actions:** Clearly label buttons and options to guide users through the complaint and request submission process.

Data Management:

- **Firebase Firestore Schema:** Design a structured database schema to efficiently store and retrieve user complaints, scrap requests, and other relevant data.
- **Real-time Updates:** Utilize Firebase's real-time database capabilities to provide instant updates to users, municipality personnel, and scrap collectors.

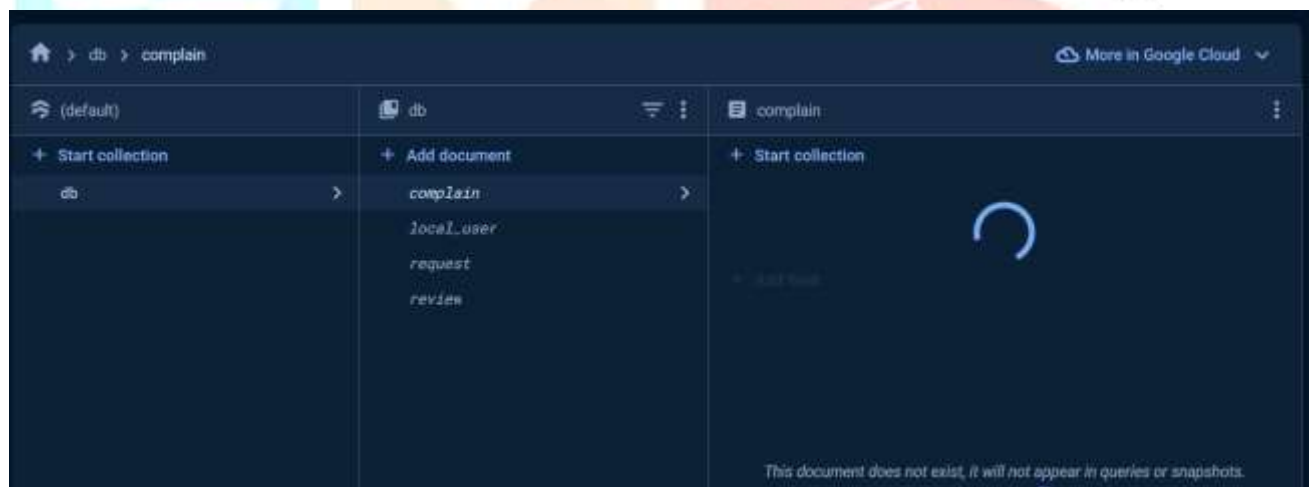


Figure.9 Database

Security:

- **User Authentication:** Implement Firebase Authentication to secure user accounts and restrict access to authorized users only.
- **Data Encryption:** Ensure sensitive data, such as user credentials and complaint details, are encrypted both in transit and at rest.

Performance Optimization:

- **Lazy Loading:** Implement lazy loading for images and components to improve initial page load times.
- **Minification and Compression:** Minify and compress CSS, JavaScript, and other assets to reduce load times and improve performance.

Scalability:

- **Serverless Architecture:** Leverage Firebase Cloud Functions for scalable backend logic that can automatically scale based on demand.
- **Horizontal Scaling:** Design the application to easily scale horizontally by adding more instances or resources as the user base grows.

Testing and Debugging:

- Unit Testing: Write automated tests to ensure the reliability and stability of critical application components.
- Error Logging: Implement error logging mechanisms to track and debug issues in production.

Documentation:

- API Documentation: Provide detailed documentation for any APIs or backend services used in the application.
- User Manual: Create a user manual to guide users through the application features and functionality.

IX. ACKNOWLEDGMENT

This work was supported by the Principal Dr. V. A. Kulkarni and management of KLS VDIIT, Dr. Shrinivas Sirdeshpande, HoD of the Computer Science and Engineering Department, my internal guide Dr. Shrinivas Sirdeshpande, Prof. Abhay Inchal from the Computer Science & Engineering Department, and all the teaching and non-teaching staff of the Department of Computer Science and Engineering..

REFERENCES

- [1] Kittiya Thibuy , Sorawit Thokrairak , Prajaks Jitngernmadan (Holistic Solution Design and Implementation for Smart City Recycle Waste Management) (Burapha University Chon Buri, Thailand63910158@go.buu.ac.th).
- [2] Vu Duong , Ashfaq Ahmed , Omer Farook (A Model Template Green Environment Initiative for Recycling Plastic Bottles with Progressive Entrepreneurship Partnership Design Consultant Center CEE Duy Tan University), (Vietnam Purdue University Northwest Hammond, Indiana, USA).
- [3] S. Kaza, L. Yao, P. Bhada-Tata and V. W. Frank, ("What a waste 2.0: A global Snapshot of Solid Waste Managment to 2050", 2018, [online] Available: <https://openknowledge.worldbank.org/handle/10986/30317>).
- [4] G. Mittal, K. B. Yagnik, M. Garg, and N. Krishnan. Spotgarbage:(Smartphone App to Detect Garbage Using Deep Learning.) UbiComp, 2016 .
- [5] Sean Bell, Paul Upchurch, Noah Snaveley, and Kavita Bala, ("Material recognition in the wild with the materials in context database.") Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 3479-3487, 2015.